MEMO DRAFTS

MEMORANDUM

INTERMOUNTAIN POWER SERVICE CORPORATION

TO: George Cross

CC: Jerry Hintze, James Nelson

FROM: Dennis Killian

DATE: August 27, 2002

SUBJECT: Primary/Secondary Air Heater Replacement

This memo is a recommendation on upgrading the SAH's and suppling cost estimates for the 2003-04 and 2004-05 budgets.

It is recommended that IPSC upgrade the SAH's with the Air Preheater Company's (Alstom) ClearFlow technology starting the March 2004 outage. Cost analysis shows payback in under 2 years with a Benefit-to-Cost Ratio of 12.3.

There is not sufficient justification at this point to recommend PAH replacement. This submission is based on an economic payback of about 4.5 years and a Benefit-to-Cost Ratio of 4.6. However, restoration of the PAH's will continue to be evaluated on a year to year basis.

Total project cost for both Units for replacement of the SAH's is estimated at approximately $3.3 Million.

Contact Bret Kent at ext. 6447 with questions.

DBK/

Attachments: 1)S:\ENGINEER\OSENGINEER\1BRET-K\AH\Clearflow.doc
2)S:\ENGINEER\OSENGINEER\1BRET-K\AH\Duplex Upgrade Brochure.doc

Background

General

The significant advances in air heater technology warrants the evaluation of alternative designs to achieve improved efficiency. A preliminary assessment demonstrated that an upgrade of the Secondary Air Heaters is viable. As a result of this study, the scope of the investigation was expanded to include the Primary Air Heaters. It is the determination of this assessment that the Air Preheater Company's (Alstom) replacement-in-kind and their ClearFlow upgrade are the only practical option currently on the market. Description of these systems is included at the end of the background section.

The following budgetary numbers were used in calculating payback.

- Fuel Cost: $1.52/million BTU
- Power Production Cost: $0.025/KW
- Labor Rate $35.00/hr

The result are as follows, with detail under the corresponding section:

SAH *(Annually per Unit)*	Replacement In-Kind	ClearFlow w/ Duplex Sealing
Fuel Savings:	$0	$654,116
Fan Savings:	$320,033	$220,666
Total Savings:	**$320,033**	**$874,782**
Installation:	$210,560	$467,600
Materials:	$923,700	$1,153,900
Total Cost:	**$1,134,260**	**$1,621,500**
Pay Back [Yrs]:	3.54	1.85

PAH *(Annually per Unit)*	Replacement In-Kind	ClearFlow w/ Duplex Sealing	ClearFlow w/ Duplex Sealing & LRS-2k
Fuel Savings:	$0	$74,223	$74,223
Fan Savings:	$23,350	$19,758	$23,639
Total Savings:	**$23,350**	**$93,981**	**$97,862**
Installation:	$45,850	$210,560	$210,560
Materials:	$125,000	$207,200	$332,200
Total Cost:	**$170,850**	**$417,760**	**$542,760**
Pay Back [Yrs]:	7.32	4.45	5.55

Primary Air Heaters

Present operating conditions show pressure differential for the PAH's running at an average of 2.70 INWC. This is 54% above design point of 1.75 INWC. Alstom estimates that this is costing IPSC $46,700 annually in PA Fan energy costs.

Labor

- RIK man-hour estimates show that 6 men working 10 hour shifts will complete the change out for 1 PAH in 7.5 shifts.
- ClearFlow and Duplex labor estimates call for 6 men working 12 hour shifts to complete change out for 1 PAH in 32 shifts.
- An Alstom provided Field Service Engineer will cost $700/day

This time table could be compressed by adding more labor and/or by combining common tasks for the 2 Primary Air Heaters in each Unit.

Payback (per Unit)

A. <u>ClearFlow w/ DL7 one layer element</u>

ClearFlow, Duplex Seal, and DL7 Elements

1. Fuel Savings(annual): $93,981
2. Material Cost: $207,200
3. Labor Cost: $210,560
4. Total Cost Per Unit: $417,760

Assuming a project life of 15 years, O&M escalation at 3% and 6.35% cost of money, also assuming operation and maintenance on the new system is $10,000 per year in present value (PV), and assuming we will realize a savings of $93,981 annually (in present value), the following is projected:

Project Life in Years:	15
O&M Rate	3.00%
Cost of Money Rate:	6.35%
Annual O&M Cost (PV):	$10,000
Annual Savings (PV):	$93,981
Capital Cost (PV):	$417,760
Salvage Value (PV):	$0

FV of O&M Cost:	$185,989
PV of Total O&M Cost:	$73,863
Total Cost over Life of Project:	$491,623
PV of Annual Savings Over Life of Project:	$2,246,721

Payback Period in Years:	4.45
Benefit/Cost Ratio:	4.57

B. <u>ClearFlow w/ DL7 one layer element and LRS-2k</u>
LRS02k is an additional seal that eliminates the 3/8" gap.
1. Additional Savings (annual): $3,880
2. System Cost: $125,000

Assuming a project life of 15 years, O&M escalation at 3% and 6.35% cost of money, also assuming operation and maintenance on the LRS-2k system is $2,000 per year in present value (PV), and assuming we will realize a savings of $3,880 annually (in present value), the following is projected:

Project Life in Years:	15
O&M Rate	3.00%
Cost of Money Rate:	6.35%
Annual O&M Cost (PV):	$2,000
Annual Savings (PV):	$3,880
Capital Cost (PV):	$125,000
Salvage Value (PV):	$0

FV of O&M Cost:	$37,198
PV of Total O&M Cost:	$14,773
Total Cost over Life of Project:	$139,773
PV of Annual Savings Over Life of Project:	$92,756

Payback Period in Years:	32.22
Benefit/Cost Ratio:	0.66

Secondary Air Heaters

Data prior to the March 2002 Outage show the SAH pressure differential average was 7.00 INWC (during the 950MW test, differential pressures in Unit 2 peaked at over 10 INWC). This is 126% above their design point of 3.10 INWC. This 3.9 INWC pressure differential could be realized in an equivalent $640,000 annual savings in power consumption on the ID Fans, through in-kind basket replacement and general heater refurbishment.

Labor

- RIK man-hour estimates show that 12 men working 12 hour shifts will complete the change out for 1 SAH in 16 shifts.

- ClearFlow and Duplex labor estimates require 12 men working 12 hour shifts to complete change out for 1 SAH in 37.5 shifts.
- An Alstom provided Field Service Engineer will cost $700/day

This time table could be compressed by adding more labor and/or by combining common tasks for the 2 Secondary Air Heaters in each Unit.

Payback (per Unit)

<u>ClearFlow w/ DL7 two layer element</u>

ClearFlow and DL7 Elements

1. Fuel Savings(annual): $874,782
2. Material cost: $1,153,900
3. Labor Cost: $467,600
4. Total Cost per Unit: $1,621,500

Assuming a project life of 15 years, O&M escalation at 3% and 6.35% cost of money, also assuming operation and maintenance on the new system is $10,000 per year in present value (PV), and assuming we will realize a savings of $874,782 annually (in present value), the following is projected:

Project Life in Years:	15
O&M Rate	3.00%
Cost of Money Rate:	6.35%
Annual O&M Cost (PV):	$10,000
Annual Savings (PV):	$874,782
Capital Cost (PV):	$1,621,500
Salvage Value (PV):	$0

FV of O&M Cost:	$185,989
PV of Total O&M Cost:	$73,863
Total Cost over Life of Project:	$1,695,363
PV of Annual Savings Over Life of Project:	$20,912,646
Payback Period in Years:	1.85
Benefit/Cost Ratio:	12.34

Definition of Options Presented

Replacement In-kind (RIK)
In-kind Replacement would consist of replacement of DL elements and general air heater refurbishment. It would restore the air heaters to design specifications. Lost performance would be regained, but no additional capability provided.

ClearFlow
There are several advantages to the Alstom ClearFlow upgrade.

First, the ClearFlow upgrade will eliminate the support grating between the soot blower and the element sheets used to support each element. Instead, stay plates installed between the diaphragms will carry the element baskets. Presently, the area behind the support grating bars is not easily cleaned, as a result of obstructions to the cleaning media.

Secondly, going to the two layer element design isolates the fouling zone to the cold end layer. Since this area is where the soot blowing energy is maximized, fouling is conversely minimized. When the soot blowing media leaves the element layer, the media energy dissipates to the sides and energy is lost rapidly. This occurs on each layer, so consequently in a three layer design the intermediate layer receives less cleaning energy and the hot end layer significantly less. In most cases, a ClearFlow up-grade requires less soot blowing frequency and less soot blowing pressures thereby extending the life of the heating element.

Lastly, with reduced obstruction and better cleanout, the fan power requirements are cut. This not only saves in power costs, but in the mechanical life of the fan.

DL7
A ClearFlow upgrade could use several different types of heating elements. Since each element profile is designed for a particular fuel or fouling problem, the optimized selection (for the proposed replacement) are the DL7 elements. The DL7 are a loose pack element, same as the existing DL profile, but with a higher thermal performance, allowing a drop from 3 layers to 2.

Another option available with the ClearFlow up-grade is not only turning over (or flipping) the element baskets, as with the present heaters, but because both the hot end and cold end layers are the same depth (41"), the hot and cold end layers can be switched as the elements wear. This allows for more even wear on the hot and cold ends of each layer.

Duplex Sealing
With the existing air heater design, one radial and one axial seal (attach to the diaphragm plate) are constantly in contact with a stationary sealing surface. In practice, this single seal provides a leakage reduction that is influenced by the amount of pressure differential that causes the leakage. If two seals are in contact with the sealing surface at the same time, the second seal surface is influenced by a reduced pressure differential that results from the pressure drop across the first seal. Duplex sealing incorporates two seals at each stationary sealing surface to effectively reduce pressure differential by 50% and direct leakage by 30%. This is accomplished by modifying the rotor to double the number of diaphragms and seals. See the attached brochure.

LRS-2K
The PAH leak as a result of excessive seal war during startup. Because hot gas is flowing through the PAH when the PA fan in not operating, the rotor takes on an extreme upward thermal deformation that would not normally be experienced when air is flowing to dissipate heat from the gas flow. This upward expansion causes the outboard ends of the hot radial and cold ends of the axial seal to "scrub out", resulting in excessive seal gaps when normal operation is obtained. At present approximate 3/8" gaps exist in the PAH's at the outboard hot radial locations in a cold condition when this gap should be 0". With the LRS-2K the seal plate is positioned away from the seals during start up, once the heater reaches normal operating conditions, the sealing plate would reposition to close the gap and minimize leakage.

MEMORANDUM

INTERMOUNTAIN POWER SERVICE CORPORATION

TO: George Cross

CC: Jerry Hintze, James Nelson

FROM: Dennis Killian

DATE: August 26, 2002

SUBJECT: Primary/Secondary Air Heater Replacement

General

The Secondary Air Heater Baskets in both units are severely eroded and have been identified for replacement by Maintenance. This memo is a recommendation on upgrading the SAH's and suppling cost estimates for the 2003-04 budget.

The significant advances in air heater technology warrant evaluation of alternative designs to achieve improved efficiency. A preliminary assessment demonstrated that an upgrade of the Secondary Air Heaters is viable. As a result of this study, the scope of the investigation was expanded to include the Primary Air Heaters. It is the determination of this assessment that the Air Preheater Company's (Alstom) replacement-in-kind and their ClearFlow upgrade are the only practical option currently on the market. Description of these systems is included under the background section of this memo.

It is recommended that IPSC replace the SAH's with the ClearFlow technology starting the March 2004 outage with Unit 2. There is not sufficient justification at this point to recommend PAH replacement. This submission is based on economic payback and is presented below. The following budgetary numbers were used in calculating payback.

- Fuel Cost: $1.52/million BTU
- Power Production Cost: $0.025/KW
- Labor Rate $35.00/hr

PAH (Annually per Unit)	Replacement In-Kind	ClearFlow w/ Duplex Sealing	ClearFlow w/ Duplex Sealing & LRS-2k
Fuel Savings:	$0	$74,223	$74,223
Fan Savings:	$23,350	$19,758	$23,639
Total Savings:	**$23,350**	**$93,981**	**$97,862**
Installation:	$45,850	$210,560	$210,560
Materials:	$125,000	$207,200	$332,200
Total Cost:	**$170,850**	**$417,760**	**$542,760**
Pay Back [Yrs]:	7.32	4.45	5.55

SAH (Annually per Unit)	Replacement In-Kind	ClearFlow w/ Duplex Sealing
Fuel Savings:	$0	$654,116
Fan Savings:	$320,033	$220,666
Total Savings:	**$320,033**	**$874,782**
Installation:	$210,560	$467,600
Materials:	$923,700	$1,153,900
Total Cost:	**$1,134,260**	**$1,621,500**
Pay Back [Yrs]:	3.54	1.85

Primary Air Heaters

Present operating conditions show pressure differential for the PAH's running at an average of 2.70 INWC. This is 54% above design point of 1.75 INWC. Alstom estimates that this is costing IPSC $46,700 annually in PA Fan energy costs.

Labor

- RIK man-hour estimates show that 6 men working 10 hour shifts will complete the change out for 1 PAH in 7.5 shifts.
- ClearFlow and Duplex labor estimates call for 6 men working 12 hour shifts to complete change out for 1 PAH in 32 shifts.
- An Alstom provided Field Service Engineer will cost $700/day

This time table could be compressed by adding more labor and/or by combining common tasks for the 2 Primary Air Heaters in each Unit.

Payback (per Unit)

A. <u>ClearFlow w/ DL7 one layer element</u>

ClearFlow, Duplex Seal, and DL7 Elements

1. Fuel Savings(annual): $93,981
2. Material Cost: $207,200
3. Labor Cost: $210,560
4. Total Cost Per Unit: $417,760
5. Payback: 53 months

B. <u>ClearFlow w/ DL7 one layer element and LRS-2k</u>

LRS02k is an additional seal that eliminates the 3/8" gap.

1. Additional Savings (annual): $3,880
2. System Cost: $125,000
3. Payback: 32+ years

Secondary Air Heaters

Data prior to the March 2002 Outage show the SAH pressure differential average was 7.00 INWC (during the 950MW test, differential pressures in Unit 2 peaked at over 10 INWC). This is 126% above their design point of 3.10 INWC. This 3.9 INWC pressure differential could be realized in an equivalent $640,000 annual savings in power consumption on the ID Fans, through in-kind basket replacement and general heater refurbishment.

Labor

- RIK man-hour estimates show that 12 men working 12 hour shifts will complete the change out for 1 SAH in 16 shifts.
- ClearFlow and Duplex labor estimates require 12 men working 12 hour shifts to complete change out for 1 SAH in 37.5 shifts.
- An Alstom provided Field Service Engineer will cost $700/day

This time table could be compressed by adding more labor and/or by combining common tasks for the 2 Secondary Air Heaters in each Unit.

Payback (per Unit)

<u>ClearFlow w/ DL7 two layer element</u>

ClearFlow and DL7 Elements

1. Fuel Savings(annual): $874,782
2. Material cost: $1,153,900
3. Labor Cost: $467,600
4. Total Cost per Unit: $1,621,500
5. Payback: 22 months

Recommendations

Although the PAH performance is severely degraded, it is not recommended that they be replaced at this time. This recommendation is based on the structural condition and economic payback greater than 4 years. However, restoration of the Primary Air Heaters will continue to be evaluated on a year to year basis.

Since the SAH's are in need of replacement and the additional cost of the upgrade can be recovered in less than 1 year, it is recommended that funds be allocated to replace the Secondary Air Heaters, starting with Unit 2 in 2004. Total project cost for both Units is estimated at approximately $3.3 Million.

Contact Bret Kent at ext. 6447 with questions.

DBK/

Attachments: 1)S:\ENGINEER\OSENGINEER\1BRET-K\AH\Clearflow.doc
2)S:\ENGINEER\OSENGINEER\1BRET-K\AH\Duplex Upgrade Brochure.doc

Background

Replacement In-kind (RIK)

In-kind Replacement would consist of replacement of DL elements and general air heater refurbishment. It would restore the air heaters to design specifications. Lost performance would be regained, but no additional capability provided.

ClearFlow

There are several advantages to the Alstom ClearFlow upgrade.

First, the ClearFlow upgrade will eliminate the support grating between the soot blower and the element sheets used to support each element. Instead, stay plates installed between the diaphragms will carry the element baskets. Presently, the area behind the support grating bars is not easily cleaned, as a result of obstructions to the cleaning media.

Secondly, going to the two layer element design isolates the fouling zone to the cold end layer. Since this area is where the soot blowing energy is maximized, fouling is conversely minimized. When the soot blowing media leaves the element layer, the media energy dissipates to the sides and energy is lost rapidly. This occurs on each layer, so consequently in a three layer design the intermediate layer receives less cleaning energy and the hot end layer significantly less. In most cases, a ClearFlow up-grade requires less soot blowing frequency and less soot blowing pressures thereby extending the life of the heating element.

Lastly, with reduced obstruction and better cleanout, the fan power requirements are cut. This not only saves in power costs, but in the mechanical life of the fan.

DL7

A ClearFlow upgrade could use several different types of heating elements. Since each element profile is designed for a particular fuel or fouling problem, the optimized selection (for the proposed replacement) are the DL7 elements. The DL7 are a loose pack element, same as the existing DL profile, but with a higher thermal performance, allowing a drop from 3 layers to 2.

Another option available with the ClearFlow up-grade is not only turning over (or flipping) the element baskets, as with the present heaters, but because both the hot end and cold end layers are the same depth (41"), the hot and cold end layers can be switched as the elements wear. This allows for more even wear on the hot and cold ends of each layer.

Duplex Sealing

With the existing air heater design, one radial and one axial seal (attach to the diaphragm plate) are constantly in contact with a stationary sealing surface. In practice, this single seal provides a leakage reduction that is influenced by the amount of pressure differential that causes the leakage. If two seals are in contact with the sealing surface at the same time, the second seal surface is influenced by a reduced pressure differential that results from the pressure drop across the first seal. Duplex sealing incorporates two seals at each stationary sealing surface to effectively reduce pressure differential by 50% and direct leakage by 30%. This is accomplished by modifying the rotor to double the number of diaphragms and seals. See the attached brochure.

LRS-2K

The PAH leak as a result of excessive seal war during startup. Because hot gas is flowing through the PAH when the PA fan in not operating, the rotor takes on an extreme upward thermal deformation that would not normally be experienced when air is flowing to dissipate heat from the gas flow. This upward expansion causes the outboard ends of the hot radial and cold ends of the axial seal to "scrub out", resulting in excessive seal gaps when normal operation is obtained. At present approximate 3/8" gaps exist in the PAH's at the outboard hot radial locations in a cold condition when this gap should be 0". With the LRS-2K the seal plate is positioned away from the seals during start up, once the heater reaches normal operating conditions, the sealing plate would reposition to close the gap and minimize leakage.

MEMORANDUM

INTERMOUNTAIN POWER SERVICE CORPORATION

TO: George Cross

CC: Dennis Killian, Jerry Hintze, James Nelson

FROM: Bret Kent

DATE: July 2, 2002

SUBJECT: Primary/Secondary Air Heater Replacement

General

The Secondary Air Heater Baskets are severely worn and have been identified for replacement by Maintenance. The design pressure differential for the Secondary Air Heaters was 3.1 INWC. Our current operating pressure differential (for 4 Secondary Air Heaters) can be averaged to 7.2 INWC (during the 950MW test, differential pressures peaked at over 10 INWC). This 4.1 INWC pressure differential could be realized in an equivalent $640,000 annual savings of power consumption on the ID Fans, through in-kind basket replacement and general heater refurbishment.

The significant advances in air heater technology warrants the evaluation of alternative designs to achieve improved efficiency. A preliminary assessment demonstrated that the upgrade of the Secondary Air Heaters to be extremely viable, in terms of economic payback. As a result of this study, the scope of the investigation was expanded to include the Primary Air Heaters. This assessment was constrained to the Alstom ClearFlow design, however, options from other suppliers are currently being evaluated.

The Alstom payback calculations use a comparison between the existing Air Heaters (operating at design specifications) and their ClearFlow design. As mentioned earlier, the current condition of the Secondaries allow for an added 30% in fan cost savings, on a replacement-in-kind. The ClearFlow design would trim some of that margin through an increase in the pressure differential by approximately 1.2 INWC.

Replacement is slated to start the March 2004 outage with Unit 2.

The following budgetary numbers were used in calculating payback.

- Fuel Cost: $1.52/million BTU
- Power Production Cost: $0.025/KW
- Labor Rate $35.00/hr

Primary Air Heaters

Labor

The labor estimate proposed by Alstom provides for 6 persons working 12 hour shifts to complete the upgrade of each rotor in 2,196 man-hours. This would require a total of 64 shifts to complete each unit (2 rotors). This time table could be compressed by adding more labor or by combining common tasks for the 2 Primary Air Heaters. Labor can be calculated at 8 hours straight plus 4 hours OT per shift, totaling $188,160. In addition, an Alstom provided Field Service Engineer will cost $700/day for 30 days, totaling $21,000. This brings the total labor cost to $209,160 for replacement of both Primary Air Heaters in a unit.

Payback (per Unit)

A. <u>ClearFlow w/ DL7 one layer element</u>

ClearFlow, Duplex Seal, and DL7 Elements

1. Fuel Savings(annual): $70,631
2. Material Cost: $207,200
3. Labor Cost: $209,160
4. Total Cost Per Unit: $416,360
5. Payback: 71 months

B. <u>ClearFlow w/ DL7 one layer element and LRS-2k</u>

LRS02k is an additional seal that eliminates the 3/8" gap.

1. Additional Savings (annual): $3,880
2. System Cost: $125,000
3. Payback: 32+ years

Present operating conditions show the PAH's running at an average of 2.7 INWC. This is 1 INWC above design. Alstom estimates that this is costing IPSC $46,700 annually in PA Fan energy costs.

Secondary Air Heaters

Labor

The labor estimate proposed by Alstom provides for 12 persons working 12 hour shifts to complete the upgrade of each rotor in 5,400 man-hours. This would require a total of 75 shifts to complete each unit (2 rotors). This time table could be compressed by adding more labor or by combining common tasks for the 2 Secondary Air Heaters. Labor can be calculated at 8 hours straight plus 4 hours OT per shift, totaling $441,000. In addition, an Alstom provided Field Service Engineer will cost $700/day for 30 days, totaling $21,000. This brings the total labor cost to $462,000 for replacement of both Secondary Air Heaters in a unit.

Payback (per Unit)

A. ClearFlow w/ DL7 two layer element

ClearFlow and DL7 Elements

1. Fuel Savings(annual): $554,749
2. Material cost: $1,153,900
3. Labor Cost: $462,000
4. Total Cost per Unit: $1,615,900
5. Payback: 35 months

Since the Secondary Air Heaters were slated for replacement, the actual cost would be the difference between the ClearFlow and replacement-in-kind. Assume labor cost are equal.

B. ClearFlow w/ DL7 two layer element

ClearFlow and DL7 Elements

1. In-kind replacement: $923,700
2. 'Actual' cost: $1,153,900 - $923,700 = $230,200
3. 'Actual' Payback: 5 month

Present operating conditions show the SAH's running at an average of 7.2 INWC. This is 4.1 INWC above design. Alstom estimates that this is costing IPSC $640,000 annually in FD Fan energy costs.

Recommendations

Because the Primaries are in fairly good shape and the economic payback is greater than 5 years, it is recommended that replacement of the Primary Air Heaters wait until performance gets notably worse.

The LRS02k system should not be installed. The loss of efficiency caused by 3/8" gap does not justify the capital expenditure.

Since the Secondaries are in need of replacement and the additional cost of the upgrade can be recovered in less than half a year, it is recommended that funds be allocated to replace the Secondary Air Heaters, starting with Unit 2 in 2004 and Unit 1 in 2005. Total project cost should total less than $3.3 Million.

Background

ClearFlow

There are several advantages to the Alstom ClearFlow upgrade.

First, the ClearFlow upgrade will eliminate the support grating between the soot blower and the element sheets used to support each element. Instead, stay plates installed between the diaphragms will carry the element baskets. Presently, the area behind the support grating bars is not easily cleaned, as a result of obstructions to the cleaning media.

Secondly, going to the two layer element design isolates the fouling zone to the cold end layer. Since this area is where the soot blowing energy is maximized, fouling is conversely minimized. When the soot blowing media leaves the element layer, the media energy dissipates to the sides and energy is lost rapidly. This occurs on each layer, so consequently in a three layer design the intermediate layer receives less cleaning energy and the hot end layer significantly less. In most cases, a ClearFlow up-grade requires less soot blowing frequency and less soot blowing pressures thereby extending the life of the heating element.

Lastly, with reduced obstruction and better cleanout, the fan power requirements are cut. This not only saves in power costs, but in mechanical life of the fan.

DL7

A ClearFlow upgrade could use several different types of heating elements. Since each element profile is designed for a particular fuel or fouling problem, the optimized selection, for the proposed replacement, are the DL7 elements. The DL7 are a loose pack element, same as the existing DL profile, but with a higher thermal performance, allowing a drop from 3 layer to 2.

Another option available with the ClearFlow up-grade is not only turning over (or flipping) the element baskets, as with the present heaters, but because both the hot end and cold end layers are the same depth (41"), the hot and cold end layers can be switched as the elements wear. This allows for more even wear on the hot and cold ends of each layer.

Duplex Sealing

With the existing air heater design, one radial and one axial seal, attach to the diaphragm plate, are constantly in contact with a stationary sealing surface. In practice, this single seal provides a leakage reduction that is influenced by the amount of pressure differential that causes the leakage. If two seals are in contact with the sealing surface at the same time, the second seal surface is influenced by a reduced pressure differential that results from the pressure drop across the first seal. Duplex sealing incorporates two seals at each stationary sealing surface to effectively reduce pressure differential by 50% and direct leakage by 30%. This is accomplished by modifying the rotor to double the number of diaphragms and seals. See the attached brochure.

PAH							

MEMORANDUM

INTERMOUNTAIN POWER SERVICE CORPORATION

TO: George Cross

CC: Dennis Killian, Jerry Hintze, James Nelson

FROM: Bret Kent

DATE: May 21, 2002

SUBJECT: Primary/Secondary Air Heater Replacement

15 SEC RULE

SHIPLEY 4 BOX SYSTEM

General

The Secondary Air Heater Baskets are severely worn and have been identified for replacement by Maintenance. The design pressure differential for the Secondary Air Heaters was ORIGINALLY 3.10 INWC. Our current operating pressure differential (for 4 Secondary Air Heaters) can be averaged to 7.9 INWC (during the 950MW test, differential pressures peaked at over 10 INWC). This approximate 5 INWC pressure differential could be realized in an equivalent 30% savings of power consumption on the ID Fans, through basket replacement and general heater refurbishment.

BOILER ΔP IS BIGGEST ECONOMIC MOTIVATOR

The significant advances in air heater technology warrants the evaluation of alternative designs to achieve improved efficiency. A preliminary assessment demonstrated that the upgrade of the Secondary Air Heaters to be ECONOMICALLY ~~extremely~~ viable~~, in terms of economic payback~~. As a result of this study, the scope of the investigation was expanded to include the Primary Air Heaters. This assessment was constrained to the Alstom ClearFlow design, however, options from other suppliers are currently being evaluated.

LETS TALK ?

The Alstom payback calculations use a comparison between the existing Air Heaters (operating at design specifications) and their ClearFlow design. As mentioned earlier, the current condition of the Secondaries allow for an added 30% in fan cost savings, on a replacement-in-kind. The ClearFlow design would trim some of that margin through an increase in the pressure differential by approximately 1.2 INWC. DESIGN? ORIGINAL? CURRENT?

BASED ON APPROVAL IN THE 03-04 BUDGET, Replacement ~~is slated to start~~ WOULD OCCUR FIRST ON UNIT 2 DURING the March 2004 outage ~~with Unit 2.~~

The following budgetary numbers were used in calculating payback.

- Fuel Cost: $1.52/million BTU

IP7_034110

- Power Production Cost: $0.025/KW
- Labor Rate $35.00/hr

PLEASE GIVE MORE ATTENTION TO ANTICIPATE TEMP DIFFERENTIALS. (i.e. OPERATING GUARANTEES)

Primary Air Heaters

2 SHIFTS/DAY ?

Labor
The labor estimate proposed by Alstom provides for 6 persons working 12 hour shifts to complete the upgrade of each rotor in 2,196 man-hours. This would require a total of 64 shifts to complete each unit (2 rotors). This time table could be compressed by adding more labor or by combining common tasks for the 2 Primary Air Heaters. Labor can be calculated at 8 hours straight plus 4 hours OT per shift, totaling $188,160. In addition, an Alstom provided Field Service Engineer will cost $700/day for 30 days, totaling $21,000. This brings the total labor cost to $209,160 for replacement of both Primary Air Heaters in a unit.

Payback (per Unit)

A. <u>ClearFlow w/ DL7 one layer element</u>
ClearFlow, Duplex Seal, and DL7 Elements
1. Fuel Savings(annual): $70,631
2. Material Cost: $207,200
3. Labor Cost: $209,160
4. Total Cost Per Unit: $416,360
5. Payback: 71 months

PLEASE DISCUSS SPECIFICS OF SEALING SYSTEM IMPROVEMENTS

B. <u>ClearFlow w/ DL7 one layer element and LRS-2k</u>
LRS02k is an additional seal that eliminates the 3/8" gap.
1. Additional Savings (annual): $3,880
2. System Cost: $125,000
3. Payback: 32+ years

WE NEED TO DO PAHS BOTH OR EITHER OR SAHs IN 28 DAYS MAX. THIS INCLUDES ALL STARTUP + V OUT. WE WILL HAVE TO ESTABLISH GUARANTEED MILESTONE SCHEDULE ETC.

Secondary Air Heaters

Labor
The labor estimate proposed by Alstom provides for 12 persons working 12 hour shifts to complete the upgrade of each rotor in 5,400 man-hours. This would require a total of 75 shifts to complete each unit (2 rotors). This time table could be compressed by adding more labor or by combining common tasks for the 2 Secondary Air Heaters. Labor can be calculated at 8 hours straight plus 4 hours OT per shift, totaling $441,000. In addition, an Alstom provided Field Service Engineer will cost $700/day for 30 days, totaling $21,000. This brings the total labor cost to $462,000 for replacement of both Secondary Air

Heaters in a unit.

ASSUMED THERMAL FACTORS?

PLEASE ALSO INCLUDE A B/C RATIO ANALYSIS.

Payback (per Unit)

A. <u>ClearFlow w/ DL7 two layer element</u>

ClearFlow and DL7 Elements

1. Fuel Savings(annual): $554,749
2. Material cost: $1,153,900
3. Labor Cost: $462,000
4. Total Cost per Unit: $1,615,900
5. Payback: 35 months

Since the Secondary Air Heaters were slated for replacement, the actual cost would be the difference between the ClearFlow and replacement-in-kind. Assume labor cost are equal.

I APOLOGIZE FOR NOT BEING CLEARER ABOUT THIS BUT AS I THINK NOW WE NEED TO ~~INCLUDE~~ ESTABLISH THE NEED FOR REPLACING THE EXISTING ELEMENTS AS WELL. (I.E. THE PERFORMANCE (THERMAL) MUST JUSTIFY THE CHANGEOUT)

B. <u>ClearFlow w/ DL7 two layer element</u>

ClearFlow and DL7 Elements

1. In-kind replacement: $923,700
2. 'Actual' cost: $1,153,900 - $923,700 = $230,200
3. 'Actual' Payback: 5 month

Recommendations

Because the Primaries are in fairly good shape and the economic payback is greater than 5 years, it is recommended that replacement of the Primary Air Heaters wait until performance gets notably worse. SEAL/THERMAL CREDIT? PA FAN CAPACITY LETS TALK.

The LRS02k system should not be installed. The loss of efficiency caused by 3/8" gap does not justify the capital expenditure.

Since the Secondaries are in need of replacement and the additional cost of the upgrade can be recovered in less than half a year, it is recommended that funds be allocated to replace the Secondary Air Heaters, starting with Unit 2 in 2004 and Unit 1 in 2005. Total project cost should total less than $3.3 Million.

Background

ClearFlow

There are several advantages to the Alstom ClearFlow upgrade.

First, the ClearFlow upgrade will eliminate the support grating between the soot blower and the element sheets used to support each element. Instead, stay plates installed between the diaphragms will carry the element baskets. Presently, the area behind the support grating bars is not easily cleaned, as a result of obstructions to the cleaning media.

Secondly, going to the two layer element design isolates the fouling zone to the cold end layer. Since this area is where the soot blowing energy is maximized, fouling is conversely minimized. When the soot blowing media leaves the element layer, the media energy dissipates to the sides and energy is lost rapidly. This occurs on each layer, so consequently in a three layer design the intermediate layer receives less cleaning energy and the hot end layer significantly less. In most cases, a ClearFlow up-grade requires less soot blowing frequency and less soot blowing pressures thereby extending the life of the heating element.

Lastly, with reduced obstruction and better cleanout, the fan power requirements are cut. This not only saves in power costs, but in mechanical life of the fan.

DL7

A ClearFlow upgrade could use several different types of heating elements. Since each element profile is designed for a particular fuel or fouling problem, the optimized selection, for the proposed replacement, are the DL7 elements. The DL7 are a loose pack element, same as the existing DL profile, but with a higher thermal performance, allowing a drop from 3 layer to 2.

Another option available with the ClearFlow up-grade is not only turning over (or flipping) the element baskets, as with the present heaters, but because both the hot end and cold end layers are the same depth (41"), the hot and cold end layers can be switched as the elements wear. This allows for more even wear on the hot and cold ends of each layer.

Duplex Sealing

With the existing air heater design, one radial and one axial seal, attach to the diaphragm plate, are constantly in contact with a stationary sealing surface. In practice, this single seal provides a leakage reduction that is influenced by the amount of pressure differential that causes the leakage. If two seals are in contact with the sealing surface at the same time, the second seal surface is influenced by a reduced pressure differential that results from the pressure drop across the first seal. Duplex sealing incorporates two seals at each stationary sealing surface to effectively reduce pressure differential by 50% and direct leakage by 30%. This is accomplished by modifying the rotor to double the number of diaphragms and seals. See the attached brochure.